

**OPTIONS FOR AN AIR FORCE TACTICAL FIGHTER COMPETITION**

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## PREFACE

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Should the Congress require the purchase of more than one type of lower-cost fighter aircraft for the Air Force in order to insure competition? How would such a competition affect the costs and capabilities of the fleet? These will be important questions as the Congress continues debate over the Department of Defense budget for 1986. Key contenders in any competition are likely to be the F-16SC, a new version of the F-16C aircraft that is currently being purchased from General Dynamics, and the F-20 aircraft recently developed by the Northrop Corporation. This analysis by the Congressional Budget Office (CBO) assesses the costs and effects of alternative procurement profiles that could result from a competition. The study responds to questions posed during hearings before the Defense Subcommittee of the Senate Committee on Appropriations. In keeping with CBO's mandate to provide objective analysis, the study contains no recommendations.

Lane Pierrot, CBO's National Security Division, and Regina Carpel, formerly of CBO's Budget Analysis Division, prepared the study under the general supervision of Robert F. Hale, John D. Mayer, Jr., and Michael Miller. Robert Kornfeld, of CBO, provided extensive assistance during the study's preparation. The authors gratefully acknowledge the contributions of Bonita J. Dombey, Patricia H. Johnston, and William P. Myers, all of CBO.

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## SUMMARY

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The Air Force currently plans to increase the number of its tactical fighter wings from 36 to 40 by the end of fiscal year 1991, while modernizing its forces and replacing older aircraft as they retire. To accomplish these goals, the Air Force intends to procure 1,284 aircraft over the next five years. Of these, 1,008 aircraft are scheduled to be F-16s and 276 are to be F-15s. <sup>1/</sup> CBO estimates that this program would require from 2 percent to 7 percent annual real growth in the tactical air force budget from fiscal years 1986 through 1990.

The Congress recently has expressed interest in using competition to hold down the costs of Defense Department weapons systems. In particular, the conference report of the House and Senate Armed Services Committees on the fiscal year 1986 budget directs the Air Force to procure at least part of its fighter force through competitive bidding.

This study finds that, relative to the Administration's February 1985 budget plan, competition would reduce the cost of buying fighters by as much as \$3.6 billion from fiscal years 1986 through 1990 and \$400 million in 1986 (see Summary Table). These savings would not result, however, from price competition that leads to lower costs for the same product. Instead, these savings reflect purchases of aircraft with a range of capabilities, including some in the low end of the range. In a period of severe fiscal restraint, the presence of such lower-cost fighter options—which might be more likely if there are two or more manufacturers—could be useful to decisionmakers. Moreover, total savings could be even larger than \$3.6 billion if—for a given mix of fighters—competition resulted in lower prices than are now expected, but CBO cannot estimate the magnitude of these potential reductions.

Among the three major contenders in a fighter competition, this study finds that General Dynamics's F-16SC would be the cheapest to procure and offers less risk than Northrop's F-20, which still must clear some development hurdles. But complete reliance on the F-16SC would end competition, since only General Dynamics would be producing lower-cost fighters. The advantages of the F-16SC must be weighed against the benefits of preserving fighter competition.

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1. Air Force five-year plan submitted with the fiscal year 1986 budget in February 1985.

## KEY CONTENDERS

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Although many aircraft could be considered in such a competition, only three are currently major contenders:

- o The **F-16C** is a single-seat, single-engine fighter produced by General Dynamics. The plane can perform multiple missions, including air combat and attack of surface targets. The Air Force plans to procure 1,008 F-16s over the next five years, of which the majority will be F-16Cs. (These plans also include some advanced F-16Fs.) The average "unit procurement" cost would be \$15.6 million each. (The unit procurement costs include initial spare parts and ground support equipment.)
- o The **F-20** is a newly developed plane to be produced by the Northrop Corporation. The F-20 is also a single-seat, one-engine fighter capable of multiple missions. In an unsolicited proposal, Northrop offered to sell the Air Force a minimum of 396 F-20s for \$12.8 million each under a four-year contract.
- o The **F-16SC** is a "specially configured" F-16C proposed by General Dynamics in response to the Northrop offer. The plane is a basic model of the F-16C, in which a number of systems have been downgraded in capability or eliminated to reduce costs. The company offered to sell the Air Force 216 of these fighters under a multi-year contract that would also include 504 fully configured F-16C aircraft. General Dynamics says the unit procurement price for each F-16SC would be \$10.9 million.

## EFFECTS OF ALTERNATIVE OUTCOMES

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CBO analyzed options that illustrate possible outcomes of competition among the three contending aircraft. All options discussed below assume that the Air Force will procure 600 F-16Cs and 276 of the most capable F-15 aircraft to meet various mission needs. Of the total 1,284 aircraft that the service plans to buy, the remaining 408 planes would be available for competition.

**SUMMARY TABLE. OPTIONS FOR TACTICAL AIRCRAFT PROCUREMENT**  
(By fiscal year)

Option	Number Procured 1986-1990			Savings 1986-1990 (In billions of current dollars)	Life Cycle Cost (Percent of Administration Plan) a/	Percent of Capability Improvement by 1992
	F-16C	F-16SC	F-20			
Administration's Plan	1,008 b/	0	0	0	100	38
Option 1	600	0	408	2.3	90	34
Option 2	600	408	0	3.6	89	35
Option 3A	600	156	252	2.7	90	34
Option 3B	600	252	156	2.9	90	34

a. Assuming:

- o 20-year service life
- o 4 percent annual real discount rate

b. The Administration's plan includes some advanced F-16Fs in this number.

#### Pure Outcomes

Option 1. The first option assumes a "pure" outcome in which the F-20 wins all 408 aircraft available for competition. The major advantage of Option 1 is that, because the F-20 is less expensive than a fully configured F-16C, investment costs over the next five years would be \$2.3 billion lower than under the Administration's program. Option 1 eventually would also reduce operating and support costs since the F-20 costs less to operate than a fully configured F-16C. This reduction is reflected in 20-year, discounted life cycle costs that equal 90 percent of those under the Administration's plan.

Additionally, Northrop has offered warranties for performance, aircraft availability, and maintainability. Another fighter production line would also increase U.S. capacity to produce quantities of fighter aircraft quickly in the event of war.

Option 1 would, however, offer less capability than the Administration's program. By 1992--when all aircraft purchased under the options are assumed to be delivered--improvement in capability over today's level would be about 34 percent, rather than 38 percent for the more costly Administration program. Less improvement would occur because the F-20 has a

smaller payload and a shorter range than the F-16C. (The model used by CBO to estimate the improvement in capability has important limitations, including some subjectivity and omissions of variables like tactics and luck; nonetheless, it provides a useful guide for comparing options.)

Moreover, the F-20 has not entirely completed its development phase, thus increasing the uncertainty of capability and cost estimates. Design changes could be deemed necessary as development continues, which could raise costs. The Northrop Corporation has offered a multi-year, fixed-price contract that might obviate the risk of higher costs. But the contract is based on assumptions--including multi-year purchases and certain levels of Air Force procurement and foreign sales--that might not be realized and could jeopardize prices. For all these reasons, Option 1 would be more risky than the Administration's program, which would procure more fully tested planes.

Option 2. Under this option, the F-16SC would win the fighter competition for all 408 aircraft. Relative to the Administration's program, five-year savings under Option 2 would total \$3.6 billion, with \$400 million saved in 1986. Operating costs would also be lower than under the Administration's plan, leading to 20-year life cycle costs that equal 89 percent of the Administration's program.

Compared to Option 1 with its F-20s, this approach would save about \$1.3 billion more in procurement costs over the next five years because the F-16SC costs less per plane than the F-20. However, the F-16SC costs more to operate than the F-20 so that discounted life cycle costs are about the same as under Option 1.

Capability under Option 2--with 35 percent improvement by 1992--would about equal that of Option 1, although it would be lower than under the Administration's plan. This option would be less risky than Option 1 because it simply removes systems from an existing plane, rather than procuring a totally new one.

Despite the advantages discussed above, Option 2 would present a major drawback: it would end competition in the tactical air fighter forces. If the Air Force did not buy any Northrop F-20s, only General Dynamics would remain to produce lower-cost fighters.

Studies of the effect of competition in the defense marketplace reach mixed conclusions. One study suggested that certain competitions--principally those involving complex systems procured in fairly small quantities, like fighter aircraft--could actually increase costs. But at least two recent competitions--one between two manufacturers of fighter engines and another between General Dynamics and Northrop for Navy training fighters--appear to have saved money.

Moreover, competition might yield another benefit--one more difficult to quantify or to identify in studies. Traditionally, aircraft have increased in cost over time in part because improvements have been made to increase unit capability. An earlier CBO study suggests, however, that procurement of less expensive, albeit less capable, aircraft might produce more overall capability if the savings were used to finance an increase in the size of the tactical air forces, rather than delaying force increases as the Air Force has historically done in the face of budget constraints. Often, however, decisionmakers lack a realistic, lower-price option as a basis for making the difficult choice between quantity and quality. The presence of two fighter manufacturers might cause industry and the services to continue to offer lower-cost options. Thus, the benefits of this Option 2 and its F-16SCs--capability at least equal to Option 1, lower near-term costs, and less risk because the F-16 is an established aircraft--must be weighed against the longer-run advantages of competition.

### Split Procurement

Options 1 and 2 set forth the key findings of this study, but they assume a pure strategy in which one contractor wins all the planes available for competition. Because it is also possible that the competitors could split the procurement, CBO considered two other variants. Option 3A assumes that 252 F-20s would be procured and that the remaining 156 aircraft would be specially configured F-16SCs; Option 3B assumes procurement of 252 F-16SCs and 156 F-20s.

The two split strategies blend the advantages and disadvantages of the pure approaches--favoring those of the F-16SC or those of the F-20, depending upon which aircraft is bought in larger numbers. The only significant new effect is heightened cost risk for the F-20. Buying fewer F-20s could increase Northrop's cost per aircraft as the fixed costs of development and setting up a production line would be spread over fewer aircraft. Thus, as fewer F-20s were purchased, the risk would increase that Northrop's current price would rise. (The General Dynamics F-16SC should not suffer a similar increase in cost risk, since every option buys 600 F-16Cs.) Indeed, Northrop has indicated that it might not open a production line unless the Air Force buys at least 180 aircraft. Thus Option 3B, which would purchase only 156 F-20s, might result in no competition at all.



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## INTRODUCTION

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The Air Force maintains tactical air forces to augment the capabilities of U.S. ground forces in conventional non-nuclear war. 1/ Tactical aircraft defend friendly forces against enemy air attacks and attack ground targets. The Air Force believes it needs to modernize its existing forces and to expand them to at least 40 wings from the current 36 wings. (Each wing contains about 72 operational aircraft.) To accomplish these goals, the Air Force plans to procure 1,284 aircraft from fiscal years 1986 through 1990. Of these, 1,008 are scheduled to be F-16s (mainly the "C" version with some advanced "F" models) and 276 are planned to be F-15s.

Since 1981 the Air Force has received \$18.1 billion in budget authority (adjusted for inflation) for tactical aircraft procurement to modernize and expand its forces. The principal types of aircraft procured over this period were the F-15--a high performance fighter designed to defeat enemy aircraft and designated the "high-mix" component of the tactical air forces--and the F-16--a dual role fighter capable of both air-to-air and air-to-ground combat, designated the "low-mix" component.

Although spending for procurement of tactical aircraft increased by 13 percent in real terms from fiscal years 1981 through 1985, the Air Force has not been able to modernize and expand its forces as it had planned. Indeed, the plan for force expansion continuously slipped. Current plans call for achieving a 40-wing force by 1991--five years later than the date established by the Air Force in 1981--and it is doubtful that the Air Force can meet this new goal. A recent CBO study concluded that the tactical aircraft budget would need from 2 percent to 7 percent annual real growth over the next five years to meet the modernization and expansion goals. 2/

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1. Many of the aircraft are, however, capable of carrying nuclear weapons.
  2. See Congressional Budget Office, "Tactical Combat Forces of the U.S. Air Force: Issues and Alternatives" (April 1985).

Yet the latest Congressional budget resolution provided real growth in total Department of Defense (DoD) budget authority that would barely average 2 percent a year from 1986 through 1988. 3/

One reason that the Air Force has not achieved substantial force growth, despite large budget increases, is sharp growth in the unit costs of its fighter aircraft. For example, over the past five years, the costs of each F-15 and F-16 aircraft grew at annual rates of 15 percent and 11 percent, respectively, above the annual rates of inflation. The Air Force argues that these increases are due at least in part to increases in capability.

As one way to hold down these costs, the Congress has suggested more competition in the tactical fighter program. The recent conference report of the Senate and House Armed Services Committees required competition in fiscal year 1986 for Air Force active and reserve fighter aircraft. 4/ Although the conference report did not specify which aircraft were to participate in the competition, the House Armed Services Committee had earlier recommended that the F-20 aircraft, recently developed by the Northrop Corporation, should compete against the F-16 produced by General Dynamics.

Savings from competition are difficult to estimate and are not guaranteed. At least one study suggests that savings are especially uncertain in cases like this in which the items procured are complex and quantities are relatively low. 5/ On the other hand, the presence of more than one fighter aircraft, including a low-cost variant, might provide decisionmakers with useful alternatives in a period of fiscal restraint. Moreover, the Air Force believes at least one recent competition--involving fighter engines--did result in savings. There may also have been savings

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3. The Congressional budget resolution for fiscal year 1986 holds overall defense budget authority to zero real growth in that year, and provides for real increases of about 2 percent annually thereafter under CBO economic assumptions (3 percent per year under the resolution's economic assumptions). See Congressional Budget Office, The Economic and Budget Outlook: An Update (August 1985), p. 66.
  4. See Department of Defense Authorization Act 1986, Report No. 99-235, Committee of Conference, 99:1 (1985), p. 23.
  5. See, for example, Michael N. Beltramo, Dual Production Sources in the Procurement of Weapon Systems: A Policy Analysis (RAND, 1983).

from a recent competition among the F-16, F-20, and other competitors for a Navy contract.

This paper analyzes alternative combinations of fighter procurement that could result from competition between the F-20 and two versions of the F-16, and develops the costs and capabilities of these combinations. Although the study cannot definitely attribute savings to competition, the results make clear that the presence of the F-20 and a new version of the F-16 has significantly altered the range of potential costs for further improvements in the tactical aircraft fleet.

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## AIRCRAFT CHARACTERISTICS AND CORPORATE PROPOSALS

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While many aircraft could be procured through competitive bidding, this study considers three main contenders:

- o General Dynamics's F-16C and a possible follow-on F-16F that the Air Force planned to buy as of February 1985;
- o Northrop's newly developed F-20; and
- o The F-16SC, a "specially configured" F-16 recently proposed by General Dynamics.

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### F-16C AND FOLLOW-ON F-16F

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The F-16 is a single-seat, single-engine aircraft capable of multiple missions, including air-to-air combat and attacking ground targets. A decision to produce the F-16 was made in 1977, after it won an Air Force competition for a low-cost, lightweight fighter aircraft. The F-16 was to augment the more capable, bigger, and more costly F-15. A highly maneuverable plane, the F-16 is capable of carrying up to six air-to-air missiles or 12,000 pounds of bombs for ground attack. Through 1985, the Air Force has bought or received funding for 1,139 F-16s and has procured two basic models of the plane, the F-16A and F-16C. 6/

Table 1 shows the performance characteristics of the current F-16C and the contending F-20 and F-16SC. Characterizations of fighter performance are controversial because a particular attribute has more or less importance depending on one's view, inevitably highly speculative, of the

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6. The Air Force also has B and D models of the F-16. These are two-seat training versions of the A and C. They are part of the total F-16 quantities referred to in this study.

TABLE 1. AIRCRAFT CHARACTERISTICS AND PERFORMANCE  
ESTIMATES a/

	F-16C	F-20	F-16SC
Empty Weight (in pounds)	18,496	12,049	17,289
Internal fuel	6,972	5,050	6,972
Engine thrust	25,400 - 27,578 <u>b/</u>	18,000	25,400 - 27,578 <u>b/</u>
Thrust to Weight Ratio (½ internal fuel, 2 AIM 9s)	1.13-1.22 <u>b/</u>	1.19	1.19-1.29 <u>b/</u>
Number Stores Stations (air-to-air missile/AIM 9, or AMRAAM)	6	6	6
Maximum external weapons carriage with Full Internal Fuel (in pounds)	12,000	10,000	12,000
Sortie Rate	Essentially equivalent <u>c/</u>		
Maneuverability	Essentially equivalent <u>c/</u>		
Weapons Delivery Accuracy	Essentially equivalent <u>c/</u>		
Range (Ratio F-16C/F-20) <u>d/</u>	General Dynamics Estimate		Northrop Estimate
Air-to-Air	(1.34-1.56)/1.0		1.12/1.0
Air to Surface			
HiLoLoHi Profile	1.88/1.0		1.18/1.0
LoLoLoLo Profile	1.09/1.0		1.08/1.0

SOURCE: Congressional Budget Office from U.S. Air Force, General Dynamics, and Northrop Corporation data.

- a. Except as noted, all aircraft characteristics and performance estimates have been measured by the Air Force and reported in an unclassified fashion. These characteristics should not be taken to be a complete set as there are other areas that the Air Force either has not analyzed or for which Air Force analysis is classified. Such areas as survivability and radar range, for example, might be important to the outcome of a more extensive analysis.
- b. Ratio of the thrust of the fighter engine to the weight of the plane. Thrust depends upon the inlet and the engine assumed; should the F-16 have the larger engine intake and the GE F-110 engine, the larger thrust will obtain.
- c. These are CBO judgments based on Air Force data. The actual data do vary slightly.
- d. Air Force range analysis is classified.

nature of future wars. Except as noted, the characteristics in Table 1 come from the Air Force.

Each F-16C costs about \$15.6 million (in fiscal year 1985 dollars). 7/ This so-called "procurement unit" cost includes the costs of spare parts and ground support equipment. Although costs of a fighter can be characterized in several ways, procurement unit costs provide the total procurement amount that the service would have to pay for each plane.

The Air Force also plans to procure a new "F" version of the F-16 in the late 1980s and included funding for it in the February 1985 budget submission. The F-16F might have a substantially different airframe from current versions and a longer range, although Air Force plans for the plane are tentative. While it is unclear exactly what the F-16F will cost, it seems likely that it will be more expensive than the current model. 8/

#### F-20 AND THE NORTHROP PROPOSAL

The F-20 is a one-seat, single-engine, multimission fighter aircraft. Developed in 1981 primarily as an export fighter for sale to U.S. allies, the F-20 is a relatively small, highly maneuverable plane. It has the capacity to carry six air-to-air missiles or up to 10,000 pounds of bombs for air-to-surface missions.

As Table 1 suggests, the F-20's capabilities are similar to those of the F-16C in a few areas, such as maneuverability, weapons accuracy, and sortie rate. But, by most other measures, it does not perform as well as the F-16C. As noted above, however, assessments of capability are controversial. Some analysts, for example, would consider the F-20's smaller size

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7. The procurement unit cost for an F-16C in the 1986 budget is about \$17.4 million in fiscal year 1985 dollars. The Air Force estimates the unit cost of the 720 aircraft in the multi-year proposal at \$15.6 million. This figure is more comparable to those for other fighters discussed here.
  8. Informal sources indicate that this enhanced version of the F-16 may have been dropped from Air Force plans because of fiscal constraints.

as an advantage. Indeed, it could be in some situations, like "dogfighting" against other aircraft; in a dogfight, small size might mean less visibility.

The F-20 also costs less than the F-16C. Using contractor estimates for the F-20 from a proposal discussed below, the F-20's procurement unit cost would be \$12.8 million, compared with \$15.6 million for the F-16C (in fiscal year 1985 dollars). 9/

To date, Northrop has been unable to generate enough orders for the F-20 to open a production line. Although the Department of Defense (DoD) has received requests from foreign governments for information on the aircraft's price and conditions for sales, only Bahrain has placed a definite order (for four aircraft). 10/ Some feel that Northrop has not been able to market the F-20 because it is not in the U.S. Air Force inventory.

U.S. government reaction to the F-20 has gradually become more favorable. In an October 1984 letter to The Atlantic Monthly, the Secretary of Defense stated that the Defense Department felt that, although the F-20 was capable of performing well in the scenarios that some countries might foresee, it did not have sufficient capability to be a U.S. fighter. In January 1985, however, the F-20 garnered the support of the National Guard Association of the United States (NGAUS). NGAUS suggested that the F-20 should be procured to help the Guard in its mission of defending the U.S. against attacks by strategic bombers. NGAUS based its support on two factors. First, the F-20's lower cost would enable the Air Force to modernize these air defense forces more rapidly. Second, according to the association, the plane would be more capable of performing the defensive mission than the older F-16As now in the Guard inventory, since the F-20 can be configured to carry a medium-range radar missile for which the F-16A was not configured. 11/ This support was perceived by some as presaging a thaw in the Administration's attitude toward the F-20.

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9. The F-16C's cost includes funding to buy spares and support equipment for the normal Air Force operating system, however. If the Air Force should refuse to accept Northrop's support concept, the F-20's investment cost might be higher.
  10. The request from Bahrain has apparently been filled with F-5s and is no longer outstanding.
  11. National Guard Association, "ActionGram," February 11, 1985.

In April of this year, the Northrop Corporation submitted a proposal to the Air Force offering to sell 396 F-20s for the firm fixed price of \$12.8 million each in fiscal year 1985 dollars. That price included various improvements over earlier prototypes, such as a higher-thrust engine, an improved radar, and the capacity to fire a radar missile. The corporation proposed to sell the aircraft under a multi-year procurement contract--under which DoD and the Congress agree to fund a total procurement quantity over several years and to pay cancellation penalties should that total quantity be reduced. In addition, the corporation offered to provide follow-on material and spare parts support for the aircraft for a fixed price of \$475 per flying hour (in fiscal year 1985 dollars). <sup>12/</sup> According to Northrop, this offer will be open until the end of 1985.

This proposal is novel for several reasons. First, the F-20 has already passed many development hurdles, and Northrop has funded all these efforts. Typically, the Defense Department would have participated in the development of an aircraft that is eventually to enter its inventories and would have provided much of the development funding. Although the Air Force made off-the-shelf purchases of aircraft for its previous generation of fighters and attack aircraft--F-4s and A-7s--the Navy developed these aircraft.

Second, Northrop quoted a price that is not expected to vary over the life of the production contract, which is unusual. In the absence of design changes, the price of fighter planes is expected to be high in the beginning years and to decrease as more of them are procured in any one year and as the total quantity procured increases. Northrop proposed a constant price, assuming the purchase of enough aircraft to justify opening a production line. The corporation, however, has not formally specified the minimum quantity required for Northrop to open production. The corporation's costs and its expectations about foreign sales quantities and prices are also unclear, as is the quantity at which the company would break even--that is, recoup all expenses and begin to make a profit. Northrop views these details, which bear on the minimum order needed to open a line, as proprietary information.

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12. These follow-on prices are distinct from the initial costs of spares and support equipment which are included in the unit procurement costs.



Third, Northrop's offer to support the aircraft for a fixed price per flying hour is atypical. The Air Force has contracts for logistics support for other aircraft in its inventory, but not for other fighters. Typically, support for fighter aircraft would be provided through the Air Force Logistics Command. But Northrop has offered to guarantee contract specifications for initial performance of weapons systems, workmanship, and system support. Specifically, the corporation will provide follow-on spares, off-base repairs, and class IV modifications--modifications to the plane to correct deficiencies and improve reliability--at a fixed price of \$475 per flying hour (in fiscal year 1985 dollars) for 20 years--the average life of a plane.

Thus this Northrop proposal was, and still is, unique in many ways. It did not, however, remain unchallenged for long.

#### THE F-16SC AND THE GENERAL DYNAMICS PROPOSAL

Before the Northrop offer was made, General Dynamics had offered to sell 720 F-16s to the Air Force for \$14.7 billion under a multi-year contract. <sup>13/</sup> (The Congress approved the contract in 1984, and it is currently being negotiated.) The aircraft in this offer were principally F-16Cs. In June 1985, General Dynamics offered 720 F-16s for a total price of \$13.3 billion, or \$1.4 billion less (adjusted for inflation) than the original contract. Under this new proposal, however, only 504 aircraft would be F-16Cs. The remainder of the 720 planes would be "specially configured" F-16SCs, which would account for the savings.

The F-16SC is planned as a slightly lighter aircraft than the F-16C (see Table 1), but it would have the same basic airframe and engine. The

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13. Most DoD weapons programs are funded annually, with procurement quantities requested by DoD and approved by the Congress each year. The advantage of multi-year funding, according to the DoD, is to enable contractors to have better planning both internally and with subcontractors and thus take advantage of economic procurement quantities. The Congress approved a 720 aircraft multi-year procurement contract for the F-16 in the fiscal year 1985 budget, and the Air Force signed a letter of offer for that amount early in 1985.

lighter weight of the F-16SC stems from the deletion of some of the systems that were added to the F-16 as it developed from the older "A" model to the current "C" version. Included in the deletions are improvements to the plane's avionics and radar. To the F16-SC's advantage, the lighter size would provide somewhat more thrust per pound, important in missions requiring maneuverability.

Compared with the F-20, the F-16SC is a larger aircraft (see Table 1). Moreover, by most Air Force measures, the F-16SC has similar or greater performance than the F-20. Nonetheless, the F-16SC is slightly less costly to buy than the F-20. Based on contractor data and the assumptions in each proposal, the procurement unit cost of the F-16SC is \$10.9 million compared with \$12.8 million for the F-20. <sup>14/</sup> According to General Dynamics, the difference in price reflects deletion of systems rather than a reduction in the price of the basic airframe or savings from competition. Air Force estimates of the costs of systems deleted from the "SC" version appear to validate this assertion.

In addition to the reduced investment price, General Dynamics offered to provide an operating and support system of the same type proposed by Northrop. For \$554 per flying hour (in fiscal year 1985 dollars), the company would provide spares and repair parts for the specially configured F-16SCs. This would be somewhat more expensive than the logistics support offered by Northrop, which would cost \$475 per flying hour (in fiscal year 1985 dollars). The company also offered reliability warranties, similar to those proposed by Northrop.

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14. The procurement unit cost discussed here includes funds for ground support equipment and initial spares. The F-16C is funded for the Air Force's usual support concept and for multiple missions whereas the F-16SC is funded for a contractor supported system and a single air defense mission. Should the Air Force desire its own maintenance concept or an increased number of missions, the initial costs for spares and ground support equipment would rise.

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## EVALUATION OF OPTIONS

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This year--and perhaps for the next several--the Administration and the Congress will need to choose among the various aircraft that are now available for the tactical air forces. The Congressional Budget Office considered three illustrative options that characterize possible outcomes of competitive procurement of F-16 and F-20 aircraft. All three alternatives would buy the same number of aircraft (1,284) from fiscal years 1986 through 1990, as did the Administration's February 1985 budget. Each also would procure the same number of F-15 aircraft (276)--which are not formally part of the competition.<sup>15/</sup> And each of the alternatives would purchase 600 F-16C aircraft, enough to meet many of the more demanding missions intended for F-16s. The remaining procurement of 408 aircraft would be available for competition. These 408 aircraft could be used in missions such as defense of the U.S. against enemy strategic bombers (air defense) or direct support of ground troops (close air support). Options 1 and 2 are "pure" strategies that assume the total quantity available for competition is won by one of the competitors, while two variants of Option 3 show the effects of a split buy.

Procurement costs for each alternative are based on estimates provided by the Air Force for the F-16C, by the Northrop Corporation for the F-20, and by General Dynamics for the F-16SC. Because the data are unavailable, independent estimates, particularly for the F-20, cannot be made. Operating and support costs for each alternative were estimated by the CBO assuming that, in the case of the F-16SC and the F-20, the Air Force would accept the logistics support systems proposed by each contractor.

To assess the defense capability provided by each alternative, CBO used the TASCFORM model developed by The Analytic Sciences Corporation (TASC) for the Office of Net Assessment in the Office of the Secretary of Defense. The model attempts to capture the potential capability associated with the size of the tactical forces and the capability of the aircraft that comprise them. It does contain some subjectivity, however, and does not

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15. All alternatives assume that 276 F-15s would be bought. Eight of these are F-15C model aircraft and the remainder are the new "E" model dual mission plane.

measure factors like pilot performance that might be more important to the outcome of a battle than the so-called "figures of merit" (that is, potential capability) of the aircraft. Furthermore, the model does not attempt to quantify other relevant and important factors, such as strategy, tactics, and luck. Thus, it should not be used to predict combat outcomes. Nevertheless, the model is useful in measuring trends in the potential performance of different force structures, and that is its function in this paper.

#### ADMINISTRATION'S OPTION

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The five-year defense plan submitted by the Administration in February 1985 proposed to procure 1,284 aircraft from fiscal years 1986 through 1990. Of these, 1,008 would be either fully configured F-16C models or advanced F-16Fs (see Table 2); the remainder would be F-15s. The plan would build from today's 36 tactical air wings to about 40 wings by 1991, while retiring older F-4 aircraft at about 20 years of age.

Congressional and Administration review will probably reduce the total purchases planned in the February 1985 budget. Indeed, Air Force plans submitted for DoD review would procure 54 fewer of the lower-cost aircraft during the common years of the two plans (1987 through 1990). Nonetheless, the February 1985 plan is the latest one for which full details are publicly available, and it remains the budget before the Congress for review. Thus, it is a useful baseline for this analysis.

Funds for aircraft procurement in the February 1985 budget request would grow from \$5.9 billion of budget authority in 1986 to \$7.7 billion by 1990, totalling \$34.5 billion over the five years (in current dollars). F-16 procurement alone would total \$21.9 billion over the five years, and would grow from \$3.7 billion for 180 planes in 1986 to \$5.1 billion for 216 aircraft by 1990, also in current dollars (see Table 3). Moreover, those costs might be low. The costs assume declines in the unit costs of both the F-15 and F-16 aircraft, whereas history suggests these costs could increase. <sup>16/</sup>

The Administration's option would expand the tactical air forces while also modernizing them with the most capable aircraft, thus substantially increasing capability. The TASCFORM model suggests that the potential

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16. See Congressional Budget Office, "Tactical Combat Forces of the U.S. Air Force."

TABLE 2. OPTIONS FOR PROCURING TACTICAL AIRCRAFT  
(By fiscal year, in number of aircraft)

Option	1986	1987	1988	1989	1990	1986-1990
<b>Administration's Program</b>						
F-16C/F	180	180	216	216	216	1,008
F-20	0	0	0	0	0	0
F-16SC	0	0	0	0	0	0
Total	180	180	216	216	216	1,008
<b>Option 1 F-20 Wins Competition</b>						
F-16C	120	120	120	120	120	600
F-20	60	60	96	96	96	408
F-16SC	0	0	0	0	0	0
Total	180	180	216	216	216	1,008
<b>Option 2 F-16SC Wins Competition</b>						
F-16C	120	120	120	120	120	600
F-20	0	0	0	0	0	0
F-16SC	60	60	96	96	96	408
Total	180	180	216	216	216	1,008
<b>Option 3A F-20 Emphasis</b>						
F-16C	120	120	120	120	120	600
F-20	36	36	60	60	60	252
F-16SC	24	24	36	36	36	156
Total	180	180	216	216	216	1,008
<b>Option 3B F-16SC Emphasis</b>						
F-16C	120	120	120	120	120	600
F-20	24	24	36	36	36	156
F-16SC	36	36	60	60	60	252
Total	180	180	216	216	216	1,008

SOURCE: February 1985 budget submission and Congressional Budget Office.

**TABLE 3. COST OF ADMINISTRATION PROGRAM AND SAVINGS UNDER OPTIONS (By fiscal year, in billions of current dollars) a/ b/**

	1986	1987	1988	1989	1990	1986-1990
<b>Cost</b>						
Administration's Program						
F-16C/F	3.7	3.7	4.4	5.1	5.1	21.9
<b>Savings Under Options</b>						
Option 1						
F-20 Wins						
Competition	0.2	0.2	0.3	0.8	0.8	2.3
Option 2 c/						
F-16SC Wins						
Competition	0.4	0.5	0.6	1.1	1.1	3.6
Option 3A						
F-20 Emphasis	0.3	0.3	0.4	0.9	0.9	2.7
Option 3B						
F-16SC Emphasis	0.3	0.3	0.5	0.9	0.9	2.9

**SOURCE:** Congressional Budget Office estimates from fiscal year 1986 budget submission and Northrop and General Dynamics proposals.

**NOTE:** Assumptions used in this table are:

- o Investment savings assume fixed price procurement unit costs of \$10.9 million and \$12.8 million for the F-16SC and F-20, respectively (in fiscal year 1985 dollars). Savings are taken against the fiscal year 1986 budget for the F-16.
  - o Operating, support, and initial spares costs were estimated assuming that the Air Force would accept the contractor logistics systems. Should this not occur, savings would be lower.
- a. Administration inflation assumptions used throughout table.
  - b. Numbers may not add to totals due to rounding.
  - c. For this option, CBO assumed that the 600 F-16C aircraft would have the same yearly unit procurement cost as the F-16Cs in the fiscal year 1986 Administration's budget, because the same total number of F-16s are being procured. It is possible that the configuration change from F-16C to F-16SC would be sufficient to increase the unit costs of the C models procured under this option to a level equal to those under Option 1. Should this occur, the savings over the five-year period could be reduced to about \$3.2 billion and 1986 savings to about \$300 million (current dollars).

capability of the tactical inventory by 1992--when the planes procured under this plan would have been delivered--would be 38 percent higher than it is today. 17/ But the Administration's option also requires increases in budget authority that might be difficult to achieve in an era of fiscal restraint.

#### OPTION 1--F-20 WINS COMPETITION

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To hold down costs, the Congress could mandate a competition and the purchase of some numbers of a cheaper aircraft. Specifically, Option 1 assumes that the F-20 aircraft wins the entire 408 aircraft available for competition in this paper. Under this option, F-20 procurement would begin in 1986 with procurement of 60 aircraft (see Table 2). The alternative would also procure 600 F-16C aircraft, but no specially configured F-16SC aircraft or any advanced F-16Fs.

Especially for fiscal year 1986 procurement, the F-20s purchased under this option might take longer to produce than the F-16s. The F-20 must still clear some development hurdles, including completing testing of a modified airframe and an improved engine and radar, as well as operational testing of the whole plane.

Nonetheless, this alternative would provide several important advantages over the Administration's option. Most significantly, it would reduce investment costs because the F-20 costs \$2.8 million less per plane than the F-16C. Although this alternative procures the same number of tactical aircraft as the Administration's program, savings of \$2.3 billion could be realized over the five-year period, with savings of about \$0.2 billion in 1986 (see Table 3). (All figures are in current dollars.)

These numbers suggest that Option 1 would realize savings from competition, through not the traditional kind. Savings do not represent a classic price competition resulting in lower costs for the same product.

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17. The results of the TASCFORM model reported in this paper cannot be compared with those shown in the CBO paper published in April 1985, entitled, "Tactical Combat Forces of the U.S. Air Force." This analysis includes the capability afforded by 15 squadrons of fighter interceptor aircraft intended for the strategic defense of the United States and the other does not. Strategic defense forces were included in this analysis because that is a mission for which the F-20 might be used.

Instead, they reflect savings from buying aircraft with a range of capabilities, including some in the low end of the range, which was perhaps the original intent of procuring tactical air forces with a mix of F-15s and F-16s. The F-16 was intended to be sufficiently inexpensive to be procured in quantity. Subsequent Air Force desires for capability increases in the fighter, however, have also increased its cost. This option could be viewed as a return to earlier service plans for a "high/low" capability mix, with the F-20 forming the lower end of the mix and F-15 and F-16C at the higher end of both capability and cost. While it is possible that a competition could cause contenders to reduce costs for comparable aircraft, it is impossible to estimate the size of any additional savings.

In addition to lowering investment costs, the F-20 could also offer significantly lower operating costs. Northrop expects the annual operating costs of its fighter to be much lower than those associated with the F-16C aircraft because the F-20 is both fairly simple and, the company projects, fairly reliable. CBO's projections bear out this contention: a 24-aircraft squadron of F-20 aircraft would cost almost 30 percent a year less to operate than would an F-16C squadron (see Table 4). <sup>18/</sup> (Operating costs here include all costs of personnel, fuel, spare parts, and other goods directly associated with operating a squadron and are expressed in fiscal year 1985 dollars.) Thus, over the 20 years typical of the lifetime of an aircraft, each squadron of F-20s could cost about \$270 million less to operate than a squadron of F-16s. Little of these savings would be realized in the near term, however, since the lag between procurement and delivery means most aircraft will be operated for only a short period during the next five years.

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18. CBO estimated the cost of operating and supporting an F-20 squadron at \$4,763 (in fiscal year 1985 dollars) per flight hour. This compares to a Northrop estimate of \$2,488 per flight hour. CBO's estimate was higher because:
- o The Northrop manpower package was based on an F-5E dissimilar air combat trainer squadron rather than a tactical fighter squadron, whereas CBO assumed the latter.
  - o Northrop's estimate did not include the following items but CBO's did:
    - Training ordnance,
    - Fighter pilot training, and
    - Some base maintenance supplies and depot maintenance that would need to be supplied by the Air Force under Northrop's concept.
  - o CBO used updated pay factors and fuel prices.



TABLE 4. ANNUAL OPERATING AND SUPPORT COSTS PER SQUADRON (In millions of fiscal year 1985 dollars)

	F-16C	F-20	F-16SC
Annual Operating and Support Costs	47.7	34.3	40.5

SOURCE: Congressional Budget Office estimates, using the Air Force Cost Oriented Resource Estimating Model from AF Regulation 173-13.

NOTE: Assumptions for these costs are as follows:

- o 24-aircraft squadron,
- o Operated by Tactical Air Command,
- o 300 flying hours per year, and
- o Contractor logistics systems as proposed by General Dynamics for the F-16SC and by Northrop for the F-20.

The total discounted costs associated with the aircraft procured under Option 1 (assuming a 20-year service life) could be 10 percent lower than those of the Administration's programs (see Table 5). <sup>19/</sup> These long-run life cycle costs are, however, subject to substantial uncertainty since they could be affected by alterations made to the aircraft in later years and

19. Discounting is a way to calculate, in today's dollars, the value of a future expenditure or future stream of annual expenditures--in this case, operating costs. The result is called present value. A future expenditure is discounted to its present value using the following formula:

$$\text{Present Value} = \text{Future Value} / (1 + i)^n,$$

where n = the number of years between the present year and the year in which the expenditure is made, and i = the discount rate. The discount rate used in this analysis is 4 percent in real terms.

TABLE 5. DISCOUNTED LIFE CYCLE COSTS UNDER EACH OPTION <sup>a/</sup>

	Discounted Costs (Billions of constant 1985 dollars)	Percent of Administration's Plan
Administration's Plan	29.6	100
Option 1	26.6	90
Option 2	26.2	89
Option 3a	26.6	90
Option 3b	26.6	90

SOURCE: Congressional Budget Office estimates, using U.S. Air Force, General Dynamics Corporation, and Northrop Corporation data.

Assumptions for these costs are as follows:

- o O&S costs per squadron as presented in Table 4,
  - o Investment cost from Table 3,
  - o Aircraft are delivered one-third in budget year plus one and two-thirds in budget year plus two and are operated half of the delivery year,
  - o Aircraft are lost at 7 per 100,000 flying hours due to peacetime accidents,
  - o All costs are discounted at 4 percent, and
  - o DoD constant 1985 dollars are used.
- a. Some disagreement exists concerning the appropriate discount rate, and the rate used has an impact on the results of the analysis. If the life cycle costs were not discounted at all, Option 1 which buys F-20s would produce the highest savings of the alternatives considered. This occurs because the F-20's lower O&S costs would have a larger impact on the total. If a larger discount rate were used, for example 10 percent, Option 2's lower investment costs would have a larger impact.

changes in operating tempo and aircraft missions. Furthermore, choosing a different real discount rate will affect the discounted life cycle costs. <sup>20/</sup>

Northrop's offer of performance and reliability warranties might be another advantage of the F-20. The Air Force has indicated that such warranties were a major benefit of its recent competition between aircraft engine manufacturers. In the competitive environment in which both F-16s and F-20s would be procured, the Air Force might be better able to require that aircraft manufacturers guarantee that their aircraft will perform as promised.

Finally, adding the F-20 production line would increase the U.S. industrial base for fighter aircraft. This would augment the country's ability to increase production quickly should hostilities break out.

These important advantages must be weighed against reductions in potential capability and higher risks associated with this option. While this alternative procures the same number of aircraft, it procures fewer of the more capable F-16C aircraft and none of the enhanced F-16F planes. Thus, by 1992, TASCFORM suggests that the potential capability of the tactical air force would increase over today's level by 34 percent under this option. Although this is a substantial improvement, it is still 4 percentage points less than under the Administration's proposal. The lesser capability of the F-20 reflects shorter range and smaller capability to carry external weapons, relative to the F-16C and F-16F aircraft.

Because of its development stage, there are also major risks associated with the F-20. Unlike the F-16, the F-20 is largely unknown to the Air Force. To date, only three F-20s have been produced, and they have been prototypes developed primarily for foreign military sales. Prototypes four and five are currently in production but will not be available for testing until 1987. Although Northrop states that over 580 test flight hours have been accumulated on the first three F-20 prototypes and over 14,000 hours of laboratory testing have been completed for aircraft parts, the aircraft has a substantial number of flight tests to go through before it is certified by Air Force standards. Before procurement began, for example, the F-16 had 1,400 hours of flight testing. During further testing of the F-20, the Air Force, and possibly the Northrop Corporation, could discover that design changes must be made. Such changes could increase costs.

Thus, cost uncertainty is the key effect of the F-20's state of development. Northrop has proposed a multi-year, fixed-price contract--which might to obviate cost uncertainty. But the proposal is based on a

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20. For a discussion of the discount rate, see Congressional Budget Office, "Primary Options for the Space Shuttle" (March 1985), p. 15.

number of assumptions, not all of which might be realized. The proposal assumes that the Air Force buys a total of 396 aircraft which, under this option, would occur. But it also assumes a guaranteed or multi-year purchase of aircraft, which might not occur. Northrop further assumes substantial sales to foreign countries. Yet some consider that the size of the foreign market is shrinking at the same time that the number of competitors is increasing. <sup>21/</sup> Failure to realize all the hoped-for foreign sales could increase Northrop's costs per plane, as fixed costs are spread over fewer aircraft, and increase the risk of financial difficulties that could jeopardize the contract.

Option 1 might also cause some uncertainty about costs of the F-16. In 1984 the Congress approved a multi-year contract with General Dynamics to purchase 720 F-16s. The Air Force has not signed the contract, but it has signed a letter of agreement with the company indicating intent to buy 720 F-16s over four years. Under this option, however, purchase of 600 F-16s would take place over more than four years. It is possible that there would be some charges for penalties associated with extending the time to purchase the 720 F-16s.

Operating costs of the F-20 could be higher than planned, too. The costs in this study (see Table 4) assumed that the Air Force accepted Northrop's proposal for contractor support. Northrop's warranty would make the company liable if the plane should prove less reliable or less easy to maintain than Northrop assumes. <sup>22/</sup> But the Air Force has indicated that Northrop's support proposal might not provide enough maintenance personnel

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21. A study by the Congressional Research Service, Trends in Conventional Arms Transfers to the Third World by Major Suppliers, 1977-1984 (April 1985), indicates that U.S. fighter deliveries to Third World countries decreased by 13 percent in the three-year period from 1981-1984 over the preceding three-year period. A study by the Defense Security Assistance Agency, "Arms Sales Perspective," indicates that the overall foreign market for fighter aircraft looks bleak for the next five years. In fact the agency estimates that it will be about 50 percent lower than over the preceding five-year period (though the U.S. share might be higher). The study also says that competition may be stiff for U.S. aircraft as, for one thing, more indigenous aircraft enter the market.
  22. As these warranties are dependent upon the Air Force's operating concept and have not been negotiated yet, higher reliability requirements or speed of repair than Northrop assumed could increase corporate prices. Furthermore, operating the aircraft at significantly less than the anticipated 25 flying hours per month could increase costs per flying hour.

and equipment to ensure that, under Air Force standards, the plane could be easily repaired if deployed overseas in a war. If the Air Force used its normal logistics system to operate the plane and did not secure warranties, operating costs could increase. Moreover, if the Air Force maintained the plane, its logistics system would have to bear the costs of stocking many new items associated with a relatively small number of aircraft.

Option 1, then, offers substantial costs savings but also increases capability less than would the Administration option. And the F-20 aircraft poses some important risks because of its state of development. These advantages and disadvantages must be weighed against those of the other major contender, the F-16SC.

#### OPTION 2--F-16SC WINS COMPETITION

Costs for tactical aircraft could also be held down if the F-16SC wins the competition. Specifically, Option 2 assumes that the specially configured F-16SC would win the competition for all 408 aircraft. This alternative also would continue to buy the 600 F-16Cs procured in Option 1. Under this alternative, however, no F-20s would be procured.

As with Option 1, lower investment costs would be a major advantage of this option. Since the F-16SC is less expensive than the fully configured F-16C, this option would cost \$3.6 billion less over the next five years than would the Administration's plan, and savings in 1986 would equal \$0.4 billion (see Table 3). Moreover, this option would also cost about \$1.3 billion less over the next five years than would Option 1 because the F-16SC is cheaper than the F-20. (All figures are in current dollars.)

The costs to operate the forces associated with this alternative would also be lower than under the Administration's plan. Once fully operational, each squadron of F-16SCs would cost about \$7.2 million, or 15 percent, less to operate annually than a fully configured F-16C squadron (see Table 4). Over the 20 years typical of an aircraft's life, each squadron would save about \$140 million (in fiscal year 1985 dollars). In contrast with procurement costs, however, this F-16SC option would not save as much in operating costs as Option 1 that buys F-20s. Over 20 years Option 1 would reduce operating costs by a total of \$270 million for each squadron (in fiscal year 1985 dollars). Regardless of the option, however, little of the operating savings would be realized over the next five years because of the time required to build and deliver the new aircraft.

Over the 20 years characteristic of an aircraft's life, the lower investment costs and higher operating costs of Option 2 relative to Option 1 would tend to cancel out. Thus, the 20-year discounted life cycle cost under Option 2 would be approximately equal to those under Option 1. They would, however, be 11 percent less than those of the Administration's program.

Potential capability of the tactical air forces under this option would be significantly higher than it is today, with an improvement of 35 percent by 1992 when all the planes procured would have been delivered. This is almost equal to the capability increase offered by Option 1 (34 percent), but lower than that afforded by the Administration's program (38 percent).

This alternative also continues to rely on a tested fighter. The F-16SC differs from the more advanced F-16C primarily in the type and number of combat systems--radar, navigation aids, and so forth--that are included. <sup>23/</sup> The Air Force would have experience with and confidence in the basic design and performance characteristics of the aircraft.

Significant funding for additional testing would not be required of the F-16SC, since development and operational testing were completed long ago. The Air Force might eventually put a new engine on the F-16C and possibly also on the F-16SC. If additional testing were required for a new engine, the cost and time involved should be minimal and would be performed anyway for the F-16C.

Finally, because the F-16SC is so similar to the F-16C, the Air Force would retain the flexibility to upgrade these aircraft in the future should the threat change significantly. The addition of any combat systems--or the upgrade and modification of ones included on the F-16SC--would, however, negate most of the savings realized under this alternative and might even cost more than if fully configured F-16Cs were purchased now.

In sum, Option 2 would save about \$1.3 billion more over the five-year period, and \$200 million more in 1986, while producing about the same improvement in capability. Option 2 with its F-16SCs is also less risky than F-20 procurement because it does not initiate procurement of a totally new aircraft, but simply removes systems from the existing F-16C. The major disadvantage of this alternative is that it ends competition in the Air Force's fighter procurement. Under this option, only General Dynamics would be producing lower-cost fighters.

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23. See the appendix for the systems that are included in each aircraft. Many of the systems removed from the F-16C to make it an SC are still in development.

How would a lack of competition affect costs? Studies of the effect of competition in the defense marketplace reach mixed conclusions. <sup>24/</sup> In some cases, competition might have actually increased procurement costs to the government. The risk of increased costs is more likely when competition involves complex systems procured in fairly small quantities, like fighter aircraft.

On the other hand, other competitions appear to save money, as illustrated by two recent examples. In 1983 the Air Force conducted a competition between the F-100 engine produced by Pratt and Whitney and the General Electric F-110 engine to decide which would be used in F-15 and F-16 aircraft. The Air Force estimates that the competition saved \$3.9 billion over the engine service lives or 19.3 percent of the total cost of the engines. In 1984 competition for production of Navy "adversary" aircraft achieved similar and more pertinent results. The Navy held a competition for the aircraft that is used to simulate enemy tactics. Northrop's F-20 competed against a General Dynamics F-16N aircraft tailored specifically to meet the Navy's training needs. General Dynamics won the competition based on performance and the reduced cost of the F-16N. Some of the cost reductions probably stemmed from competition. The flyaway cost of the modified F-16N was \$9.7 million, or \$2.3 million less than the flyaway cost of the F-16C. (Flyaway costs exclude spares and ground support equipment funding.) The F-16 Navy adversary aircraft did not have the same combat capability as the F-16C, but the cost of items eliminated from the F-16C to produce the F-16N did not account for all the cost reductions. Moreover, General Dynamics states that it reduced its normal airframe profit to insure that the cost of the plane was within the Navy's affordability range. <sup>25/</sup>

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24. See, for example, Michael N. Beltramo, Dual Production Sources in the Procurement of Weapon Systems: A Policy Analysis (RAND, 1983); and James P. Bell, Competition as an Acquisition Strategy: Impact of Competitive Research and Development on Procurement Costs (Institute for Defense Analysis, 1983). Drawing conclusions about the competition discussed in this paper from these studies is difficult, however, as neither of them considered competitive procurement of fighter planes this far along in development. In recent history, there have been no comparable competitions to study.
25. A letter to the Congressional Budget Office from General Dynamics, dated February 14, 1985, states, "... General Dynamics elected not to apply normal earnings to the airframe and CFE handling charges, rather to reduce them to keep the program affordable to the Navy."

Competition might yield another benefit, more difficult to quantify or identify in studies. Traditionally, as aircraft continue in procurement, both the services and industry push for increases in weapons capability that lead to increases in costs. The services argue that these improvements yield increases in capability needed to match the growing threat to U.S. security. Yet an earlier CBO study suggested that procurement of less expensive aircraft, with savings used to finance an increase in the size of the tactical air forces, might produce more overall capability. Often, however, decisionmakers lack a realistic, lower-price option as a basis for making the difficult choice between quantity and quality. If the presence of two manufacturers caused industry and the services to continue to offer lower-cost options, then competition could be useful to decisionmakers faced with a period of intense fiscal restraint.

Thus the benefits of Option 2 and its F-16SCs—with capability at least equal to the F-20 option, lower near-term costs, and less risk because the F-16 is an established aircraft—must be weighed against the longer-run benefits which might be derived from competition.

### OPTION 3--SPLIT COMPETITION

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The two preceding alternatives assume that one competitor wins the total quantity of aircraft available for competition, and those results illustrate the key findings of this study. In reality, however, competition could yield mixed buys of fighter aircraft. The following options present details about the cost and capability of two possible options that procure a mixture of F-20s and F-16SCs.

#### Option 3A--F-20 Emphasis

One possible result of the competition would be two winners, with Northrop's F-20 receiving the larger share. Option 3A procures 252 F-20 aircraft over the five years and 156 specially configured F-16s. It also continues to procure 600 F-16Cs (see Table 2). This should be a feasible option since Northrop has indicated that it would probably be willing to open a production line if the Air Force were to buy at least 180 F-20s.

Because it buys both the F-20 and the F-16SC, this approach blends the advantages and disadvantages of both the previous pure strategies with emphasis on those of the pure F-20 approach. The option would continue competition. It would also save money relative to the Administration's program. Subject to the caveats noted below, savings over the next five



years would amount to \$2.7 billion—more than the pure F-20 option (\$2.3 billion) but considerably less than the pure F-16SC strategy (\$3.6 billion). (All in current dollars.) Improvement in capability over today's level would amount to 34 percent, about the same as the pure strategies but less than the Administration's 38 percent.

This option would still contain the risks associated with the F-20, though some would be magnified and others reduced relative to the pure F-20 strategy of Option 1. This approach would buy the F-20s more slowly than Option 1, which would reduce the risk of delays in procurement because of the time needed to complete development and set up a production line. More importantly, the cost uncertainty about the F-20 might increase under this option. Northrop has indicated that it might be willing to open a production line for as few as 180 aircraft, and has stated informally that the price in its proposal would hold for quantities as low as 180. But Northrop's proposal—which provided the costs used to analyze this and other options in this paper—assumed the purchase of 396 aircraft. Unless sales to foreign countries are even larger than Northrop expects, which seems unlikely, buying 252 instead of 396 F-20s might increase Northrop's costs for the F-20; as the fixed costs of development and production were spread over fewer aircraft. This could jeopardize the contract price, especially if future contract changes required renegotiations. If the contract price rose, a portion of the savings under this mixed option would disappear.

#### Option 3B--F-16SC Emphasis

Another mixed outcome also assumes two winners, but favors General Dynamics's F-16SC. Specifically, this option assumes the purchase of 156 F-20s and 252 F-16SCs. Again, the option would procure 600 F-16Cs (see Table 2).

As before, this outcome would blend the advantages of the two pure strategies, this time emphasizing those of the F-16SC approach. The benefits of competition would continue. Again subject to cost risk, the option would save \$2.9 billion relative to the Administration's option, more than the pure strategy that buys F-20s (\$2.3 billion) but less than the F-16SC option (\$3.6 billion). (All figures in current dollars.) By 1992 capability would have increased by 34 percent over today's level, less than the Administration's 38 percent.

The small number of F-20s purchased under this option would, however, exacerbate considerably the risk of higher F-20 costs and hence lower savings for the reasons discussed above. Indeed, this option would buy only 156 F-20 aircraft, which might not be enough to prompt Northrop to open a production line. Thus, this approach runs the risk of no competition at all.

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## APPENDIX

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TABLE A-1. CONFIGURATION COMPARISON a/

System	F-16C	F-16SC	F-20	Comments
Radar	APG-68	APG-66 (modified)	APG-67 (V)	The APG-66 is an earlier generation and has less capability than either APG-67 or APG-68.
Radar Missile	AMRAAM	AMRAAM	AMRAAM	AMRAAM--Advanced Medium Range Air-to-Air Missile. Currently experiencing development/cost problems.
CHAFF/FLARE	ALE-40 (4 magazines)	None	ALE-40 (2 magazines)	Systems to decoy radar guided missiles (chaff) and infrared missiles (flares) away from aircraft.
Engine	F-110 GE-100 or F-100 PW-200/220	F-110 GE-100 or F-100 PW-200/220	F-404 GE-100	F-404 engine is similar to the engine in F/A-18 but with 2,000 lbs. more thrust.

(Continued)

TABLE A-1. (Continued)

System	F-16C	F-16SC	F-20	Comments
Inertial Navigation System	LN-39 Standard INS	LN-39 INS (Modified for quick reaction)	H-423 INS Ring Laser Gyro (Quick reaction)	Aircraft navigation system. Speed of reaction determines how quickly a plane can take off for an intercept mission.
Radar Warning Receiver	ALR-74RWR (In development)	ALR-69RWR (Improved)	ALR-69RWR (Improved)	Radar warning receivers let the pilot know when his plane has been detected by radar and where the radar is located.
Identify Friend or Foe (IFF)	IFF Mode IV Interrogator and Transponder	IFF Mode IV Transponder	IFF Mode IV Transponder	System to communicate between attacker and target to avoid fratricide. An aircraft with only a transponder cannot query its targets, though it can respond if queried.
Jammer	ASPJ (Advanced Self-Protection Jammer) (In development)	ALQ119/131 ECM Pod Group A	ALQ-135 CCS Group A	To jam enemy radars. Major difference is that ASPJ is internal to the F-16C whereas the F-16SC systems are in pods hung from the aircraft, thus increasing drag and taking up a stores station. The F-20 system is external also but is conformal to reduce drag.

TABLE A-1. (Continued)

System	F-16C	F-16SC	F-20	Comments
Infrared Targeting or Navigation Systems	LANTIRN (Low altitude navigation and targeting infra-red for night system). Not fully developed or fielded yet.	None	None	LANTIRN system intended to assist the pilots of single-seat planes in locating ground targets at night or in bad weather. Provisions for the system could be included in either F-16SC or F-20 at a price.
PLSS Precision Location Strike Systems	Capacity to communicate with system (When system deployed)	None	None	System intended to provide information on the location of moving targets to attacking forces (not yet developed).

SOURCE: Congressional Budget Office

- a. While there are other configuration differences, these appear to be the major ones.